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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/798,331

03/12/2004

Stanislav Kadlec

635.43483X00

6134

20457 7590 02/28/2008
ANTONELLI, TERRY, STOUT & KRAUS, LLP
1300 NORTH SEVENTEENTH STREET
SUITE 1800
ARLINGTON, VA 22209-3873

EXAMINER

BAND, MICHAEL A

ART UNIT

PAPER NUMBER

1795

MAIL DATE

DELIVERY MODE

02/28/2008

PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/798,331	Applicant(s) KADLEC ET AL.	
	Examiner MICHAEL BAND	Art Unit 1795	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 06 December 2007.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 36 and 49-95 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 36 and 49-95 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 10 August 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

2. Claims 36, 49-54, 57-69, 74-88, and 90-95 are rejected under 35 U.S.C. 102(b) as being anticipated by Wang (US Patent No. 6,352,629).

With respect to claims 36 and 92, Wang '629 discloses a method for sputter coating a wafer (i.e. substrate) [24] by a magnetron [36] in a vacuum chamber [12] via a high-density plasma (fig. 1; col. 4, lines 19-43). Depicted in fig. 1 is a surface of a target [16] with the magnetron [36] opposite and adjacent to the target. Also depicted in fig. 1 is a magnetic loop [B_m] which are seen generated by a first magnet subarrangement [40] and a second magnet subarrangement [42] with both first and second magnet arrangements generating magnetic fluxes through target [16] as evidenced by magnetic loop [B_m]. The magnetic flux of the second magnet arrangement [42] is also larger than the magnetic flux of the first magnet subarrangement [40] (col. 4, lines 54-56). Furthermore, fig. 1 also depicts a third magnet subarrangement (i.e. electromagnet) [40] with a magnetic flux [B_c] superimposed upon the magnetic flux [B_m]. Also the unbalanced magnetron has an unillustrated motor and drive shaft aligned to a central axis (fig. 1, [38]) that rotates the back plate of the magnetron in a sweeping motion in

Art Unit: 1795

relation to the central axis (col. 4, 44-48), where magnetic fluxes $[B_m]$, $[B_c]$ interact and move as the unbalanced magnetron is rotated.

With respect to claims 49, 51, 79, and 93-95, Wang '629 discloses a method for sputter coating a wafer (i.e. substrate) $[[24]]$ in a vacuum chamber $[12]$ via a high-density plasma (fig. 1; col. 4, lines 19-43). Depicted in fig. 1 is a surface of a target $[16]$ and a wafer with a surface $[24]$ opposite of the target (col. 4, lines 28-29). Also depicted in fig. 1 are two magnetic fields $[B_m]$, $[B_c]$ which are seen generated in the space between the target and wafer. A magnetron (fig. 1, $[36]$) forms magnetic field $[B_m]$ as a closed loop with the direction towards the target surface, as indicated by the arrows, where the tangent line to the minimum peak of $[B_m]$ is parallel to the target surface. Fig. 1 further depicts a tunnel-like arcing from an outer area of a first magnetic pole $[42]$ (col. 4, lines 54-56) to an inner area of a second magnetic pole $[40]$ (col. 4, lines 54-56), where the inner area is confined by the two magnetic fields of $[B_m]$ and where the magnetic field component perpendicular to the target surface at the center of the inner magnetic pole, and thus the center of the inner area, equals zero. An unbalanced long-range asymmetrical magnetron $[36]$ has magnetic field $[B_c]$ that is seen coming from said outer area relative of said inner area to complement (i.e. increase) the magnetic flux where the long-range field reaches the substrate surface (fig. 1; col. 5, lines 55-57). A magnetic field $[B_m]$ parallel and close to the face of the target creates a high-density plasma, where the bias on the substrate attracts metal atoms from the target in the plasma (col. 4, lines 56-67; col. 5, lines 40-44). Also the unbalanced magnetron has an unillustrated motor and drive shaft aligned to a central axis $[38]$ that rotates the back

Art Unit: 1795

plate of the magnetron in a sweeping motion in relation to the central axis (fig. 1; col. 4, 44-48).

With respect to claim 50, due to principles of magnetic flux interaction of the fluxes $[B_m]$, $[B_c]$, the second magnetic flux $[B_m]$ inherently controls the asymmetric unbalanced long-range magnetic field pattern.

With respect to claims 52 and 53, Wang further discloses a component of the magnetic field $[B_m]$ parallel to said substrate surface and magnetic field $[B_m]$ having a strength in the range of about 10 gauss to 1000 gauss (col. 5, lines 60-65) and magnetic field $[B_c]$ having a strength in the range of about 15 gauss to 100 gauss (col. 7, lines 10-17).

With respect to claim 54, Wang '629 further discloses "a sputtering target [16] composed of the metal to be sputtered is sealed to the chamber [12] through an insulator [18]. A pedestal electrode [22] supports a wafer [24] to be sputter coated in parallel opposition to the target [16] (col. 4, lines 26-29). Furthermore Wang '629 discusses how the target DC power supply (fig. 1, part 34) biases the target causing the argon working gas (fig. 1, [26]) to be excited into a plasma containing electrons and positive argon ions, where the positive argon ions are attracted to the negatively biased target and sputter metal atoms from the target (col. 4, lines 37-43).

With respect to claim 57, Wang '629 further depicts in fig. 1 magnetic flux $[B_m]$ homogenous along said outer area.

With respect to claim 58, Wang further discloses an electromagnet [40] generating the second magnetic field $[B_c]$ (col. 5, lines 20-23).

With respect to claims 59-61, Wang further discloses the unbalanced magnetron has an unillustrated motor and drive shaft aligned to a central axis [38] that rotates the back plate of the magnetron, off set from the center, in a sweeping motion in relation to the central axis (fig. 1; col. 4, 44-48), with magnetic flux interaction of the fluxes $[B_m]$, $[B_c]$, the second magnetic flux $[B_m]$ inherently controls the asymmetric unbalanced long-range magnetic field pattern. In addition, Wang further discloses the magnetic field lines (i.e. flux) extending towards the wafer (i.e. substrate) (col. 5, lines 38-41).

With respect to claim 62, Wang '629 further discloses a magnetic field $[B_m]$ inside the vacuum chamber parallel and close to the face of the target to create a high-density (i.e. maximum) plasma where the negative bias on the substrate attracts the positively charged metal ions in the plasma to the wafer (i.e. substrate) (col. 4, lines 37-43 and lines 54-67). Wang '629 further describes unbalanced magnetrons projecting the magnetic field towards the wafer, with magnetic field $[B_c]$ coming from the unbalanced magnetron to help stabilize the flow of plasma electrons, and therefore metal ions, from the target to the wafer, increasing the plasma density and leads to an increase in sputtered metal ion flux upon the wafer (col. 5, lines 29-57). An unillustrated motor and drive shaft aligned to a central axis rotates (i.e. sweeps) the back plate (and the magnetron) across the target (col. 4, lines 44-48).

With respect to claim 63, Wang '629 further discloses that the magnetic field lines extend toward the wafer (i.e. substrate) and the plasma electrons gyrate around them in a spiral pattern and travel toward the wafer, with the metal ions (i.e. current of ions) following the plasma electrons (col. 5, lines 38-44). Since the unbalanced magnetron is

Art Unit: 1795

moving via unillustrated motor (col. 4, lines 44-48), the magnetic field intensity is constantly adjusted across the target, leading to an adjustment in plasma density in relation to the target, and therefore an adjustment of metal ion density.

With respect to claims 64-66, Wang further depicts in fig. 1 the electromagnet [40] generating the second magnetic field $[B_c]$ with the coil axis parallel to the target [16] surface (col. 5, lines 35-40). Since the unbalanced magnetron is moving via unillustrated motor (col. 4, lines 44-48), the magnetic field intensity is constantly adjusted across the target, leading to an adjustment in plasma density in relation to the target, and therefore an adjustment of metal ion density. Additionally, Wang discusses utilizing AC power (i.e. current varying with time) to power the electromagnet [40] (col. 7, lines 31-36).

With respect to claim 67, Wang further depicts in fig. 1 a wafer (i.e. substrate) [24] supported on a pedestal. It is inherent that the apparatus be capable of providing more than one substrate.

With respect to claim 68, Wang further discloses the unbalanced magnetron is moving via unillustrated motor (col. 4, lines 44-48). It is well known for a semiconductor wafer, discussed in Wang, to be circular and to be arranged on a circular pedestal.

With respect to claims 69 and 76-77, Wang further discloses biasing the pedestal electrode [22] to create a negative self-bias on the wafer [24] using an RF (radio frequency) power supply [50] (col. 4, lines 61-64), with an RF power being known to pulsate. The RF bias attracts the positively charged metal atoms across a sheath of the

Art Unit: 1795

adjacent plasma, thereby coating the sides and bottoms of high aspect-ratio holes (col. 4, lines 64-67). Since RF power is pulsating, it is constantly adjusting.

With respect to claims 74 and 75, Wang further discloses “a vacuum pumping system [30] maintains the interior of the chamber [12] at a very low base pressure of typically 10^{-8} Torr or less” (col. 4, lines 32-34), with a chamber pressure during plasma ignition of 5 millitorr (col. 4, lines 34-37) and for certain sputtering to less than 1 millitorr (col. 5, lines 16-19).

With respect to claim 78, Wang further discloses sputtering copper (col. 5, lines 13-16), with the potential for use titanium and tantalum targets (col. 1, lines 20-24).

With respect to claim 80, Wang further depicts in fig. 1 an asymmetric long-range field pattern generated by a first magnetic field component $[B_m]$ along the inner and outer areas and a second magnetic field component $[B_c]$ along a section of the outer loop.

With respect to claim 81, Wang '629 further depicts in fig. 1 magnetic flux $[B_m]$ homogenous along said outer area.

With respect to claims 82-85, Wang further depicts in fig. 1 the electromagnet [40] generating the second magnetic field $[B_c]$ with the coil axis parallel to the target [16] surface (col. 5, lines 35-40). Since the unbalanced magnetron is moving via unillustrated motor (col. 4, lines 44-48), the magnetic field intensity is constantly adjusted across the target, leading to an adjustment in plasma density in relation to the target, and therefore an adjustment of metal ion density. Additionally, Wang discusses

Art Unit: 1795

utilizing AC power (i.e. current varying with time) to power the electromagnet [40] (col. 7, lines 31-36).

With respect to claims 86 and 87, Wang further discloses a component of the magnetic field $[B_m]$ parallel to said substrate surface and magnetic field $[B_m]$ having a strength in the range of about 10 gauss to 1000 gauss (col. 5, lines 60-65) and magnetic field $[B_c]$ having a strength in the range of about 15 gauss to 100 gauss (col. 7, lines 10-17).

With respect to claim 88, Wang '629 further discloses "a sputtering target [16] composed of the metal to be sputtered is sealed to the chamber [12] through an insulator [18]. A pedestal electrode [22] supports a wafer [24] to be sputter coated in parallel opposition to the target [16] (col. 4, lines 26-29). Furthermore Wang '629 discusses how the target DC power supply (fig. 1, part 34) biases the target causing the argon working gas (fig. 1, [26]) to be excited into a plasma containing electrons and positive argon ions, where the positive argon ions are attracted to the negatively biased target and sputter metal atoms from the target (col. 4, lines 37-43).

With respect to claim 90, Wang further discloses the unbalanced magnetron has an unillustrated motor and drive shaft aligned to a central axis [38] that rotates the back plate of the magnetron, off set from the center, in a sweeping motion in relation to the central axis (fig. 1; col. 4, 44-48), with magnetic flux interaction of the fluxes $[B_m]$, $[B_c]$, the second magnetic flux $[B_m]$ inherently controls the asymmetric unbalanced long-range magnetic field pattern. In addition, Wang further discloses the magnetic field lines (i.e. flux) extending towards the wafer (i.e. substrate) (col. 5, lines 38-41).

With respect to claim 91, Wang further depicts in fig. 1 a wafer (i.e. substrate) [24] supported on a pedestal. It is expected that the apparatus be capable of providing more than one substrate.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

5. Claims 55-56 and 89 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wang (US Patent No. 6,352,629) as applied to claims 1 and 79, respectively, above and in further view of Chiang et al (US Patent No 6,398,929).

With respect to claims 55-56 and 89, Wang '629 further depicts in fig. 1 that a tunnel-like magnetron field pattern [B_m] covers a percentage, at least about 50% seen from fig. 1, of the target surface. However Wang '629 is limited in that while the tunnel-

like magnetron field pattern covers a percentage of the target, a specific percentage is not suggested.

Chiang '929 teaches a similar apparatus in fig. 4 for sputtering a substrate with a magnetron [130] attached to a motor-driven drive shaft [142]. Chiang '929 also discusses how the magnetron [130] is rotated about the center [140] of the target [56] by a motor-driven shaft [142] to achieve full coverage (i.e. 100%) in sputtering of the target (col. 12, lines 9-13).

It would have been obvious to one of ordinary skill in the art to incorporate the full coverage (i.e. 100%) of Chiang '929 for the coverage percentage of Wang '629 since Wang '629 fails to disclose a specific coverage percentage.

6. Claims 70-73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wang (US Patent No. 6,352,629) as applied to claim 69 above, and further in view of Chiang et al (USPGPub 2001/0050220).

With respect to claims 70 and 71, the reference is cited as discussed for claim 69. Wang '629 further discloses a frequency for the AC power supply as being less than 1 kHz (col. 7, lines 34-37) and an RF power supply having a frequency of 13.56 MHz. However Wang '629 is limited in that while a frequency range is discussed, the claimed range is not specified.

Chiang '220 teaches sputtering on a substrate by ionized metal plasma deposition (abstract) utilizing a similar apparatus with a magnetron [106] above a substrate [110] with a vacuum pump [146] and shield [128] (fig. 1). Chiang '220 also teaches an RF power source [134] that biases the substrate (p. 2, para 0021) where the

positive and negative voltage portions are sequentially alternated to result in a series of target/coil sputtering steps resulting in a frequency of between about 1 kHz and 200 kHz (p. 3, para 0030). It is well known that an RF power source is a pulsating power source as evidenced by fig. 2. Chiang '220 lists the advantage of using this RF bias power as to influence the direction of ions in the chamber during processing (p. 1, para 0009).

It would have been obvious to one of ordinary skill in the art to use the bias RF power taught in Chiang '220 for the power source of Wang '629 in order to gain the advantage of influencing the direction of the ions during processing.

It has been held that in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" *a prima facie* case of obviousness exists. *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976).

With respect to claims 72 and 73, the reference is cited as discussed for claim 69. Wang '629 further discloses frequencies for an AC power source and a RF power source (col. 4, lines 61-67; col. 7, lines 30-37), with both power sources being pulsating. It is well known that a pulsating power source has a duty cycle or ratio associated with it. However Wang '629 is limited in that while it is inherent that a duty cycle or ratio is incorporated with an AC or RF power source, a specific duty cycle or ratio is not specified.

Chiang '220 further teaches a duty cycle associated with the frequency range discussed earlier. Chiang '220 discusses a duty cycle between about 50% and about 90% (p. 3, para 0030), leading to a conclusion that the off-time must therefore be from about 50% and about 10%. Chiang '220 lists the advantage of using this RF bias power,

Art Unit: 1795

and therefore the duty cycle, as to influence the direction of ions in the chamber during processing (p. 1, para 0009).

It would have been obvious to one of ordinary skill in the art to use the duty cycle taught in Chiang '220 for the duty cycle of Wang '629 in order to gain the advantage of influencing the direction of the ions during processing.

It has been held that in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" *a prima facie* case of obviousness exists. *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976).

Response to Arguments

112 Rejections

7. Applicant has amended the claims to specifically recite a magnetic field or magnetic field pattern. Therefore the rejection is withdrawn.

102 Rejections

8. Since Wang et al (USPGPub 2004/0020768) (i.e. Wang No. 2) was not used in the Office Action dated 8/6/2007, any arguments corresponding to the Wang No. 2 reference have not been responded too.

9. Applicant's arguments filed 12/6/2007 have been fully considered but they are not persuasive.

Art Unit: 1795

10. On pages 16-17 of the Remarks, the Applicant argues that the Wang patent (i.e. Wang No. 1) reference does not disclose an unbalanced magnetron generating an asymmetric magnetic field.

The Examiner respectfully disagrees. As stated Wang discusses using an unbalanced magnetron generating a magnetic field $[B_m]$ with varying magnetic pole intensities (col. 4, lines 5-10; fig. 1). An electromagnet [40] generates a magnetic field $[B_c]$, also depicted in fig. 1 as interacting with magnetic field $[B_m]$. As fig. 1 depicts, there are two magnetic fields $[B_m]$, $[B_c]$ on the left side of an axis [38], with only one magnetic field $[B_c]$ on the right side of said axis [38]. When magnetic field $[B_m]$ is rotated to the right side, two magnetic fields $[B_m]$, $[B_c]$ are on the right side of an axis [38] and only one magnetic field $[B_c]$ on the left side of said axis [38]. Thus, an asymmetric magnetic field flux is formed.

103 Rejections

11. On pages 22-23 of the Remarks, the Applicant argues that the Chiang patent reference does not teach an asymmetrically unbalanced magnetron.

The Examiner points out that the Chiang reference was used to teach, not an asymmetrically unbalanced magnetron, but rather a similar magnetron apparatus having a magnetic field cover a target surface. In addition, the claims Applicant points out have been cancelled and thus any arguments corresponding to them are moot.

Conclusion

12. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Michael Band whose telephone number is (571) 272-9815. The examiner can normally be reached on Mon-Fri, 8am-4pm, EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Alexa Neckel can be reached on (571) 272-1446. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

14. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should

Art Unit: 1795

you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/M. B./

Examiner, Art Unit 1795

/Alexa D. Neckel/

Supervisory Patent Examiner, Art Unit 1795